RECENT OBSERVED CHANGES IN WEATHER TYPES OVER SPAIN

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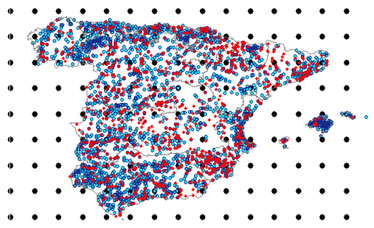
ABSTRACT

A joint probabilistic analysis of Weather Types and daily observations has been performed, in order to study and analyse changes in the meteorological phenomena and the atmospheric circulation over Spain during two recent periods of time; 1957-1979 and 1980-2002. To do so, we have generated a cluster of 100 Weather Types from the ERA-40 reanalysis data using a k-means algorithm. Results show changes in daily meteorological observations, as well as changes in the frequency of appearance of Weather Types and in the occurrence probability of different events.

DAILY DATA



888 thermometric stations
2788 pluviometric stations
1º resolution ERA-40 nodes

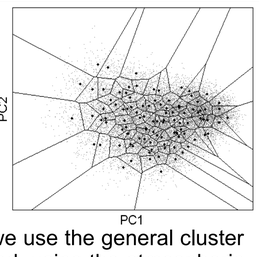
Period 1 (**P1**): 1957-1979
Period 2 (**P2**): 1980-2002

ERA-40

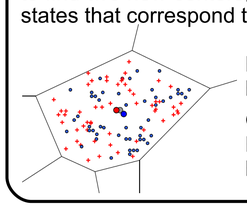
Variables: Z, T, U, V, R
Levels:1000hPa, 850hPa, 500hPa

CLUSTER ANALYSIS

Cluster of 100 WTs, using a k-means algorithm, obtained from the ERA-40 Re-analysis and validated in the space of the observations (extreme temperatures and precipitation)



In order to compare WTs in both periods we use the general cluster to find two new centers, one for each period, using the atmospheric states that correspond to each period.

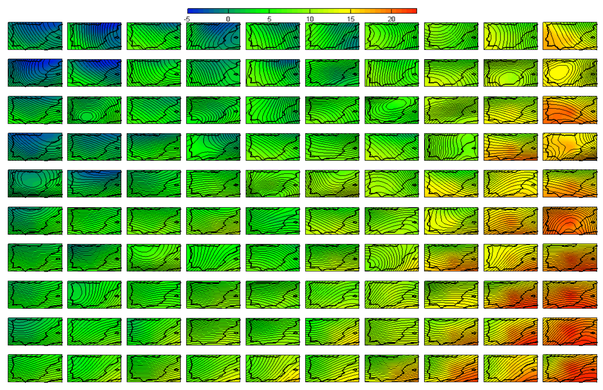


Red crosses: P1 atmospheric states
Blue dots: P2 atmospheric states

Grey circle: center of the global cluster
Red circle: center of the cluster for P1
Blue circle: center of the cluster for P2

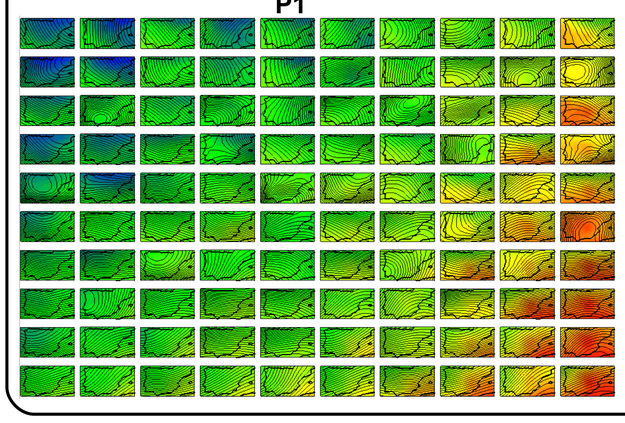
WHEATHER TYPES

ERA-40
T850
Z500

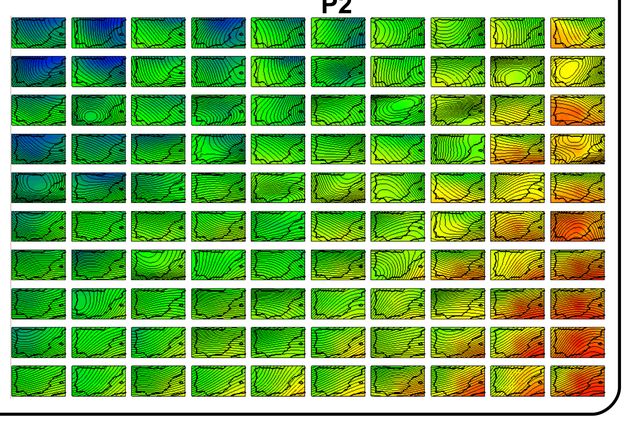


The cluster has been ordered by their atmospheric similarities

P1



P2



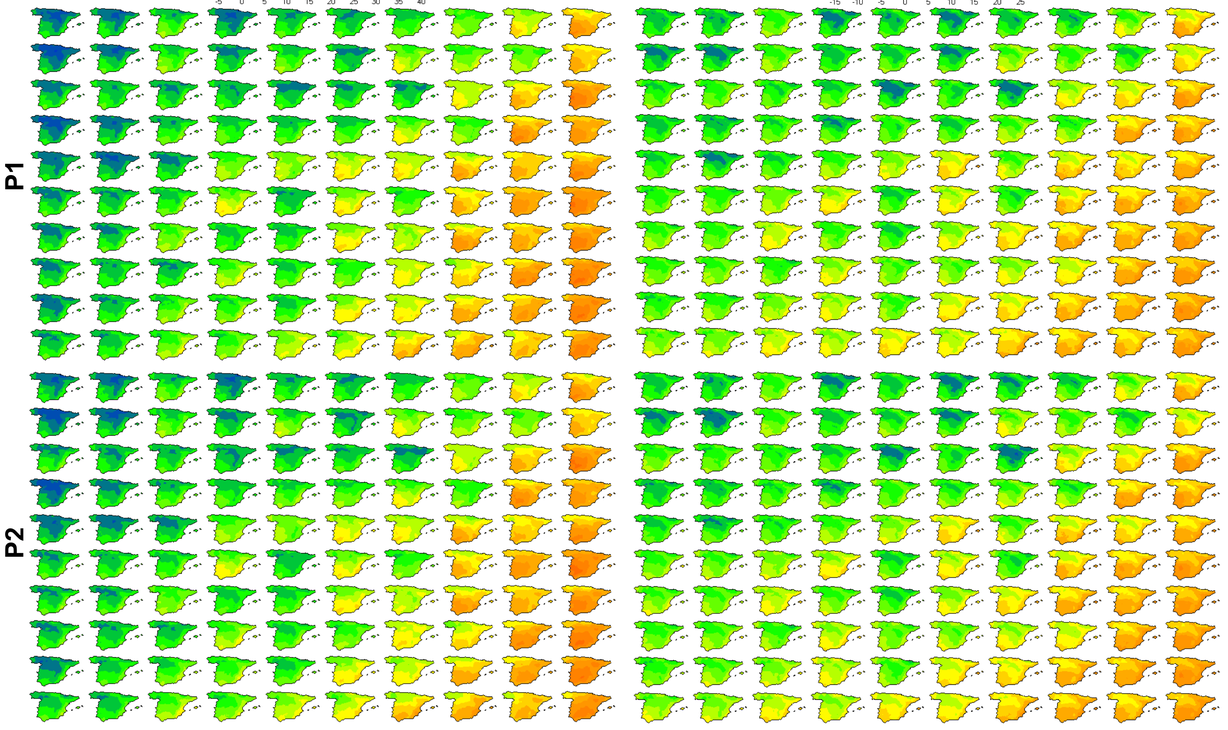
TEMPERATURE

Maximum Temperature

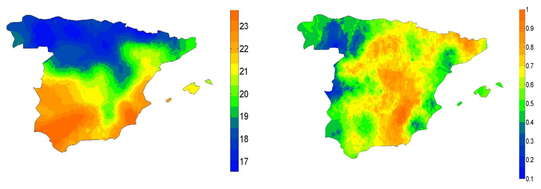
Minimum Temperature

P1

P2

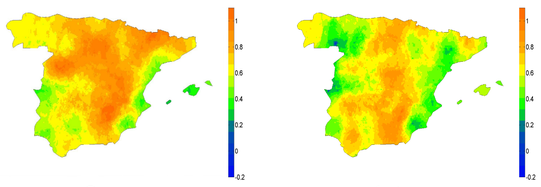


CLIMATOLOGY DIFFERENCES CLIMATOLOGY DIFFERENCES

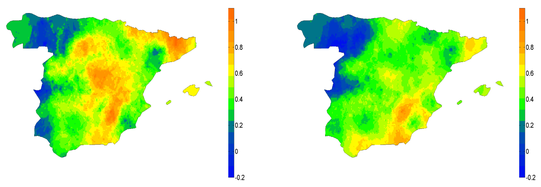


SEASONAL DIFFERENCES

Winter Spring

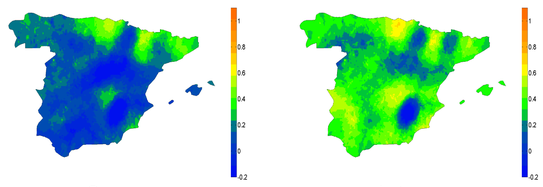


Summer Autumn

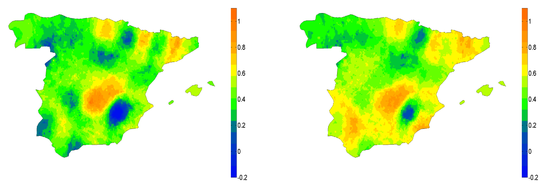


SEASONAL DIFFERENCES

Winter Spring

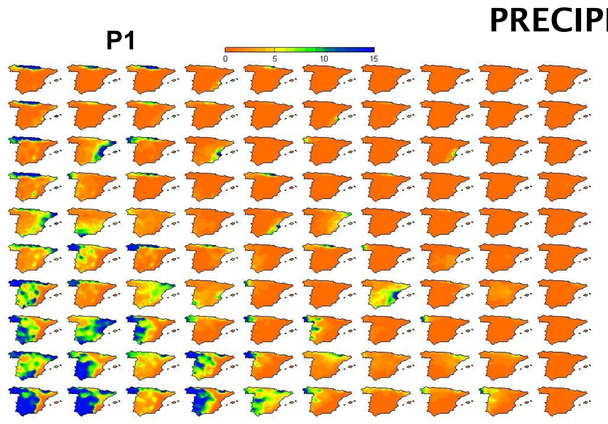


Summer Autumn

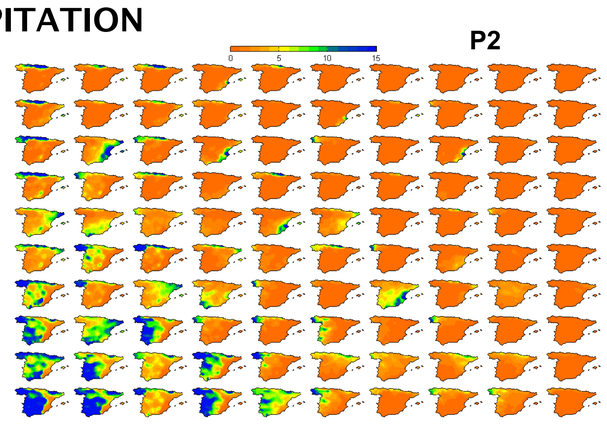


PRECIPITATION

P1

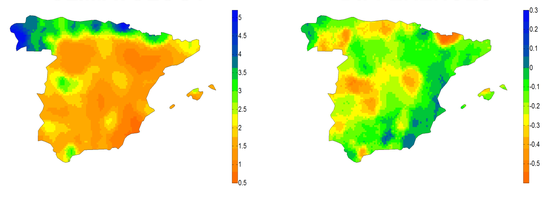


P2



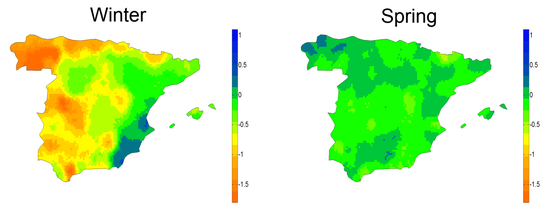
Daily Precipitation (mm)

CLIMATOLOGY DIFFERENCES

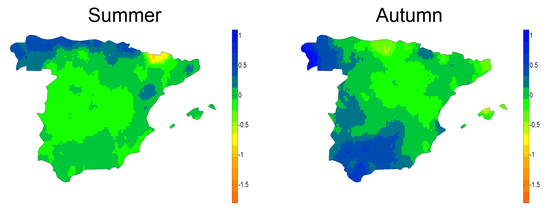


SEASONAL DIFFERENCES

Winter Spring

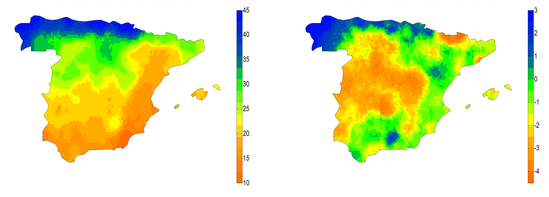


Summer Autumn



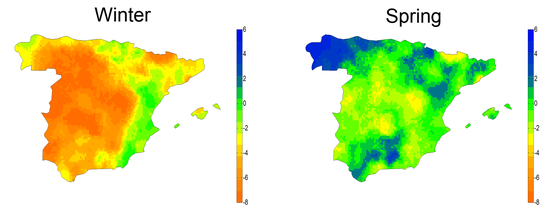
Pre > 0mm (%)

CLIMATOLOGY DIFFERENCES

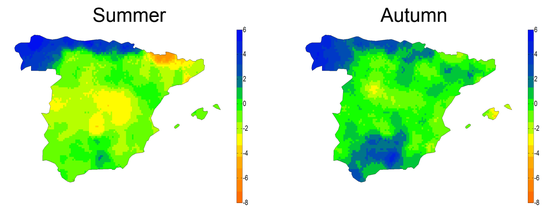


SEASONAL DIFFERENCES

Winter Spring

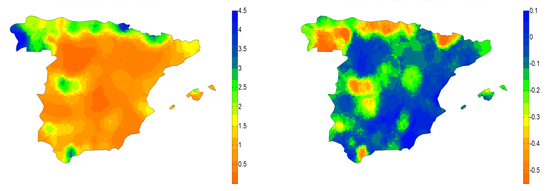


Summer Autumn



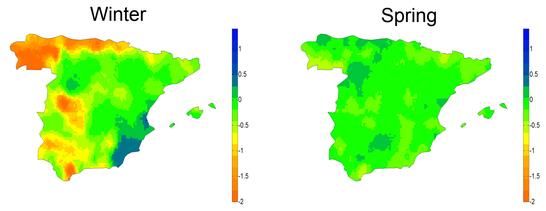
Pre > 30mm (%)

CLIMATOLOGY DIFFERENCES

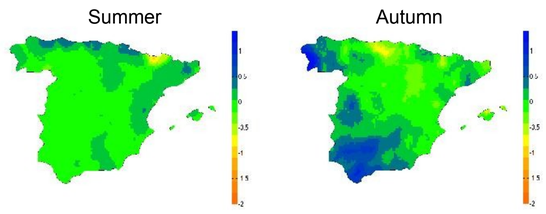


SEASONAL DIFFERENCES

Winter Spring

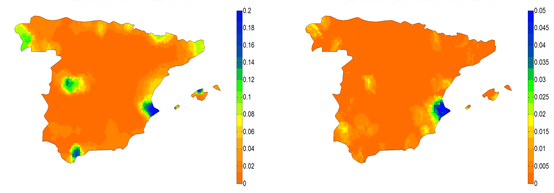


Summer Autumn



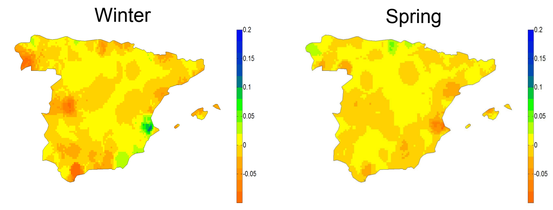
Pre > 100mm (%)

CLIMATOLOGY DIFFERENCES

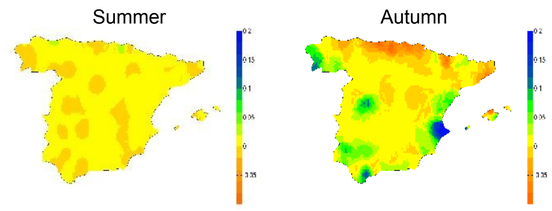


SEASONAL DIFFERENCES

Winter Spring

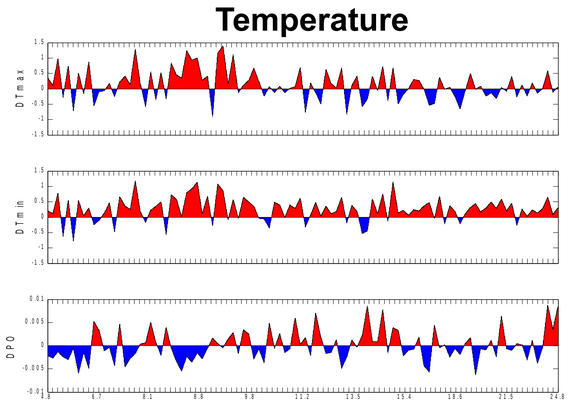


Summer Autumn



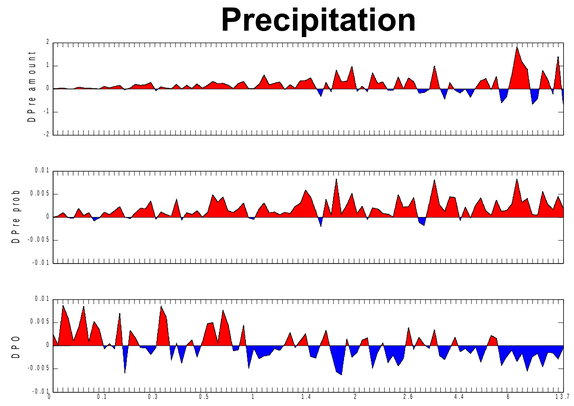
CHANGES IN WHEATHER TYPES

Temperature



WTs ordered by their mean temperature (º C) during P1

Precipitation



WTs ordered by their mean precipitation (mm) during P1

DTmax: Differences in Maximum Temperature for each WT (º C)
DTmin: Differences in Minimum Temperature for each WT (º C)
DPre amount: Differences in rainfall amount for each WT (mm)
DPre prob: Differences in rain probability for each WT (%)
DPO: Differences in the occurrence probability of each WT (%)

CONCLUSIONS

- Changes in extreme temperatures and precipitation were heterogeneous in space, time and distribution of WTs.
- Both extreme temperatures rose since 1980.
- Thermic amplitude in winter was higher during P2 than during P1.
- Almost all the WTs rose their extreme temperatures.
- The warmest WTs were more frequent during P2 and the coldest ones were less frequent.
- Results show a significant decrease in precipitation, mainly during winter.
- Although extreme precipitation WTs were even more extreme (they produced more rainy days and more rainfall amount) during P2 than during P1, they were less frequent.
- Extreme precipitation events (Pre>30mm and Pre>100mm) were more extreme during autumn since 1980, over some areas of the domain.

FUTURE WORK

- Detailed study of changes: over different regions of Spain and different WTs.
- Study changes in the transition probability of WTs.
- Study extreme events using WTs.

References

R. Ancell and J.M. Gutierrez (2007): High resolution simulations of weather sequences for binary events with Generative Classifiers. *10th International Meeting on Statistical Climatology (IMSC), Proceedings of 10th IMSC:85*
M. Bermejo and R. Ancell (2009): Statistical analysis of weather types over the Iberian peninsula domain. *Clima en España: Pasado, presente y futuro. Contribución a un informe de Evaluación del Cambio Climático Regional,* Feb. 2009, Madrid
M. Bermejo and R. Ancell (2009): Observed changes in extreme temperatures over Spain during 1957-2002, using Weather Types. *Revista de Climatología,* 9:45-61
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